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PROJECT VANGUARD REPORT NO. 19
PROGRESS THROUGH JUNE 30, 1957

[UNCLASSIFIED TITLE]

Project Vanguard Staff

August 6, 1957

NAVAL RESEARCH LABORATORY
Washington, D.C.

CONFIDENTIAL

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Project Vanguard Report No. 18, "Minitrack Report No. 1: Phase Measurement" by C. A. Schroeder, C. H. Looney, and H. E. Carpenter, NRL Report 4995 (Unclassified), July 26, 1957

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NRL Report 5010

Project Vanguard Report No. 19

ERRATA

Inside of Front Cover:

Project Vanguard Report No. 17 reports progress through May 31, 1957 (rather than June 30, 1957) and is NRL Report 4980 (rather than 5010).

Library cards bound in back of report:

The title of the report as shown on the library card should show progress through June 30, 1957 (rather than May 31, 1957).

CONTENTS

Preface	ii
Problem Status	ii
Authorization	ii
THE LAUNCHING VEHICLES	1
Design, Structure, and Assembly	1
Propulsion	1
Flight Control	4
THE SATELLITES	7
Design, Structure, and Assembly	7
Scientific Experiments and Instrumentation	9
ELECTRONIC INSTRUMENTATION	11
Telemetering	11
Vehicle Tracking	11
Range Safety	12
THE MINITRACK SYSTEM	13
System Calibration	13
Ground Station Establishment	14
DATA PROCESSING	15
Telemetered Data	15
Orbital Data	15
Third-Stage Firing Prediction	15
RANGE OPERATIONS	17

PREFACE

This report is intended as a general summary of the progress on Project Vanguard during the indicated period. Hence, minor phases of the work are not discussed to a great extent, and technical detail is kept at a minimum. It is hoped that the information here presented will be of assistance to administrative and liaison personnel in coordinating and planning their activities, and as a guide to the current status of the project. Material of a more technical nature will be published from time to time in separate reports which will be announced in subsequent monthly progress reports.

PROBLEM STATUS

This is an interim report; work on the problem is continuing.

AUTHORIZATION

NRL Problem A02-90

Manuscript submitted August 2, 1957

THE LAUNCHING VEHICLES

DESIGN, STRUCTURE, AND ASSEMBLY

With the exception of the first-stage roll jet system (see Attitude Control), final acceptance tests have been completed on TV-2 and the TV-2 backup. TV-2 was shipped to AFMTC and arrived on 17 June. Manufacturing is complete on TV-3, and horizontal testing of the first- and second-stage assemblies has begun. The installation of electrical and mechanical components in the first stage of the TV-3 backup is nearly completed, and the first-stage assembly for TV-4 is on schedule. The installation of components in the second stage of the TV-3 backup is slightly behind schedule. The TV-4 second stage is somewhat behind schedule owing to a delay in delivery of the Aerojet engine (see Propulsion - Second Stage), but fabrication of the forward section and the plastic nose cone are underway. Assembly of the first stage of the TV-4 backup is scheduled to begin early in July.

In tests recently performed by The Martin Co. on the separable plastic nose cone, the cone structure did not retain the explosive bolt and hence failed to separate. The cone is currently being modified to eliminate this difficulty.

The ejection of flares from the first stage of the vehicle to aid in optical tracking has been tested by The Martin Co., and the explosive ignition of the flares caused damage to the simulated vehicle structure. The tests will be continued with the flares in Kel-F rather than metal cases, and it is expected that no further damage will occur.

PROPULSION

First Stage

The third and fourth production X-405 first-stage powerplants, S/N-7 and S/N-8, have been accepted and delivered to The Martin Co.; they will be used in the TV-2 backup vehicle and the TV-3 backup vehicle, respectively. One major deviation from specifications was required to cover S/N-8's below-specification specific impulse of 249 seconds. This was an instantaneous value, however, and the average specific impulse for the entire firing equalled the specified value of 250 seconds.

Acceptance test firings of the fifth powerplant (S/N-9) have been completed, but the inspection is not complete. This unit, intended for TV-4, will be submitted for acceptance early in July; no major deviations from specifications are anticipated at this time.

The X-405 engine qualification program is now complete. Although some scoring of the thrust chamber of the qualification engine had been noted during preliminary tests, no further scoring was observed and no major repairs or modifications were required during the five full-duration qualification firings.

Tests of the first-stage propellant systems are continuing at the Martin Co. plant. The fuel and hydrogen peroxide flow tests have been satisfactorily completed, and testing of the oxidizer system is now in progress. Upon completion of these tests, a thorough-going flow test of the overall propellant systems will be made to verify their capacity, compatibility, and reliability.

Second Stage

The second-stage propulsion unit selected for qualification tests has undergone one acceptance test firing and two qualification test firings. After 35 seconds of burning during the last of these tests an increased oxidizer flow rate, indicating a leak, was noted. The firing was terminated by a normal shutdown at 108 seconds, and examination of the thrust chamber disclosed approximately 60 ruptures in the aluminum tubes (Fig. 1). The erosion of these tubes was such that they failed at a differential pressure of 115 psi.

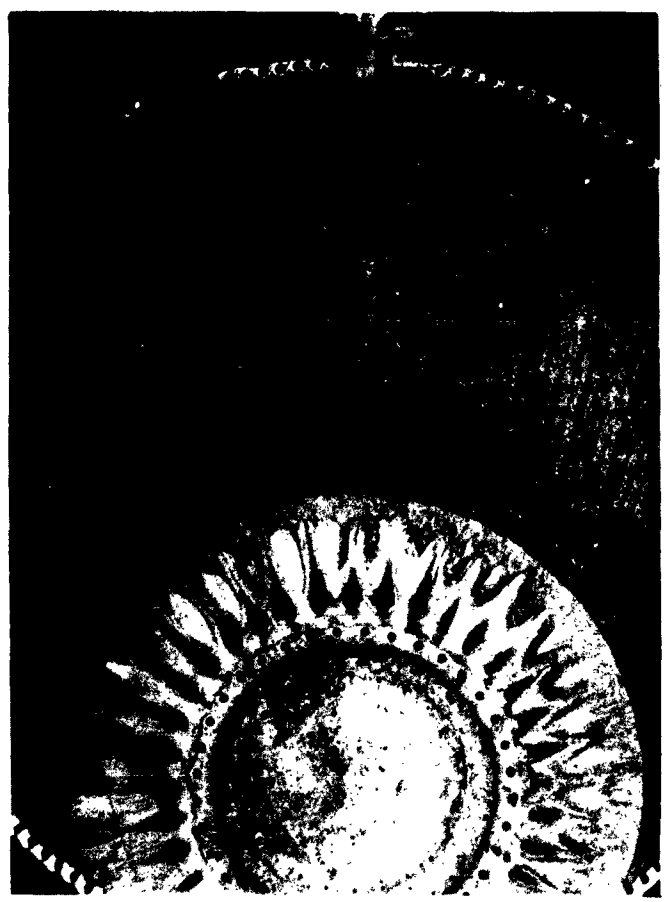

Fig. 1 - Injector and tubular walls of second-stage qualification test chamber

As can be seen in the photograph, the erosion and failures follow a definite geometric pattern; this pattern matches the pattern of the orifices in the Mod 34 injector. The two outermost concentric rings of orifices are oxidizer orifices, and each oxidizer stream from these orifices impinges on a fuel stream from two concentric rings of fuel orifices. In addition, 24 fuel orifices form the innermost ring in the central portion of the injector.

The impinged oxidizer and fuel streams burn and expand as they proceed through the chamber. The outermost ring of streams produced an erosion pattern starting at the injector face and continuing down the chamber wall (aluminum tubes) about 10 inches. The inner ring of streams produced erosion starting about 7 inches from the injector face, and more severe than that produced by the outer ring.

The more severe erosion by the streams originating farthest from the walls is believed due to turbulence and nonlongitudinal flow which broke down the insulating gas film in the hottest region of the chamber. Ideally, this film allows the aluminum surface temperature to remain about 475°F while the local flame temperature is as high as 6000°F. Momentary breakdowns of the film therefore would vaporize the aluminum on the surface; the vapor film would then tend to insulate the surface again, preventing instantaneous burn-through of the type common to regeneratively cooled thrust chambers generally. There is greater turbulence where the burning gases flow into cracks between tubes and then out again, and the erosion was found to be more severe in the region of such cracks (Fig. 2). As would be expected, the erosion was less severe where the gas flow was more nearly longitudinal.

Fig. 2 - Cross-sectional view of chamber wall tubes
7-7/16 inches from injector

The increased oxidizer flow rate which was the first indication of the burn-through occurred after a total accumulated firing time of 273 seconds. Two other thrust chambers tested during this report period burned through because of similar erosion. One of these employed a different injector (the Mod 18 used very early in the program) and this fact indicates that the problem cannot be attributed exclusively to the Mod 34 injector.

Another chamber, with a Mod 28 injector, now has a total of 325 seconds of firing and is being run to determine its lifetime. One solution to the erosion problem which has been discussed is to shorten the required lifetime to within the range of actual lifetime as determined by the life tests, if this actual lifetime is sufficient to accomplish the mission of the second stage. A meeting of The Martin Co., Aerojet-General, and NRL has been scheduled to decide upon the minimum lifetime requirement and to outline a program to determine the capability of the present engines to meet this requirement. The application of special coatings to the aluminum tubes, or anodizing of the chamber walls, is under consideration as a means of extending the chamber lifetimes if necessary. No serious delay in the launching schedule is anticipated.

Second-stage propulsion units 1 and 2, already delivered to The Martin Co.* for TV-3 and the TV-3 backup vehicle, have accumulated total firing times of 142 and 147 seconds,

*P.V.R. No. 17, p. 2

respectively. Since the required duration of a static firing in the field is only 15 seconds, and the flight duration 115 seconds, these two units are believed to be adequate for their missions.

Propulsion unit 3 was completed during this report period but was not accepted by The Martin Co. because of an improper weld in the propellant tank assembly. The trouble has been corrected but acceptance will be delayed pending the outcome of further tests.

Qualification testing of the redesigned Futurecraft regulator for the second-stage helium system is now underway.

Third Stage

Grand Central Rocket Co.

The Grand Central Rocket Co. has completed the analysis of the fuel separation and propellant cracking problems.* It was found that the problems were due largely to insufficiently close tolerances in the propellant processing methods. Procedures have been developed to provide closer tolerances and also sampling of the ingredients prior to processing.

GCR has submitted all documents required prior to the qualification tests. When these documents are approved, GCR will be authorized to cast twelve rockets and initiate the qualification test program; it is anticipated that the qualification program will begin in the second week of July and be completed by 15 October.

Allegany Ballistics Laboratory

The Allegany Ballistics Laboratory has completed the testing of the liner-less cast-in-place-propellant systems,† without a successful full-duration firing. Severe combustion instability or "resonance" was noted with this system, and further revisions of the configuration have been made in an effort to overcome this resonance. The new configuration involves casting the propellant into a liner-chamber combination, the cellulose acetate liner being previously glued to the silica-loaded rubber insulator on the inner wall of the case. The baffle-type resonance suppressor which was tried in the aforementioned tests will be abandoned in favor of the original resonance suppressor. The resulting overall configuration approximates an early configuration which exhibited no resonance but was abandoned because of repeated case burn-throughs. Since the burn-through problem has been solved, it is believed that this system now holds promise.

FLIGHT CONTROL

Guidance

Four gyro reference systems have now been delivered by the Minneapolis-Honeywell Regulator Co. and accepted. One of these will be used as an engineering test unit and the others as flight units. A fifth unit will undergo further vibration tests and will be delivered on 26 July.

*P.V.R. No. 17, p. 3

†P.V.R. No. 17, p. 4

The four delivered units were accepted with a waiver of the requirement for maximum torquer current; this in no way affects the trajectory characteristics, but limits the maximum pitch rate available for ground-command flight path trimming. The unit for TV-4 has, in addition to the four preset pitch program rates, a fifth rate of 0.04 degree per second. Since the time for third-stage firing is variable and depends on the velocity at second-stage burnout, this final pitch rate will continue to correct the vehicle attitude to compensate for the curvature of the earth during the second-stage coasting flight.

Resolution of the difficulties noted during qualification tests of the magnetic amplifier autopilot* requires that this device be powered by a separate 400-cps alternating power supply rather than the main vehicle supply. This will hold the voltage within the limits for which the autopilot can meet the specified requirements. The addition of the separate power supply imposes a weight penalty but still provides a slight weight advantage over the electronic autopilot built by The Martin Co. as a backup. Acceptance tests of the first three autopilots thus modified are scheduled for 1, 10, and 17 July, respectively. The fourth unit will be used for the qualification tests. Meanwhile, the backup electronic autopilot is on schedule.

Attitude Control

Continued efforts* to qualify the first-stage roll jet assembly have not yet been successful: the frictional torque in the main swivel bearing of the nozzle is excessive in a temperature environment of 850°F. Two alternative designs have been released to manufacturing. One utilizes an increase in the actuator force from the original 40 pounds to 200 pounds. The other design eliminates the large-bore main nozzle bearing and substitutes three external bearings which cage the nozzle, one of them mounted as a flexure member to accommodate any nozzle eccentricity. In this design the thrust component which was imposed on the main bearing (and gave rise to the excessive friction) in the original design is imposed on a special outboard bearing. It is expected, therefore, that the use of the greater actuator force will not be required. Tests on a roll jet assembly of this design will begin about 10 July.

"Live" tests of the second-stage gimbaled engine hydraulic servos have been performed during static firings of the second-stage engine. An oscillation of the thrust chamber was noted, with an amplitude of approximately 1/4 degree and at a frequency within the controls frequency band. This may have been due to forces exerted by lateral motion of the exhaust stream in the altitude (i.e., over-expanded) nozzle, which does not "flow full" during sea-level operation. The data from these tests are still being analyzed, so a complete evaluation cannot be made at this time. Similar tests will be made on the first-stage servos during firings of the X-405 engine during the next month.

The propulsion checkouts on the second-stage control jet mockup have been completed, and overall tests of the second-stage controls will be started as soon as the test facilities, currently being used for the first-stage roll jet development, are available.

Flight Program and Staging

A total of five program timers have now been delivered to The Martin Co. for acceptance. Two of these have been returned to Designers for Industry, Inc., because

*P.V.R. No. 17, p. 5

of improper sequencing of the relays. During the qualification testing of the program timer, some instability was noted in the time-base oscillator, and DFI will repeat the qualification vibration tests when this difficulty has been eliminated. Further deliveries are being withheld until the vibration requirements are met. In addition, life tests of the timer must be performed before complete qualification, which is required for the TV-3 launching.

A total of three coasting time computers have now been delivered, and a fourth is undergoing acceptance tests prior to delivery. However, the difficulties noted during the qualification vibration tests* have not yet been resolved, and further deliveries are being withheld until complete qualification is demonstrated.

*P.V.R. No. 17, p. 6

THE SATELLITES

DESIGN, STRUCTURE, AND ASSEMBLY

Group 1 Satellites

Preliminary testing of the pressurized internal instrumentation container for the Group 1 satellites* has been completed. If the results of battery tests dictate the use of this pressurized container, it will be pressurized to 8 psia; thus it will experience an expansive force of 8 psi in orbit, and a compressive force of about 8 psi from the sea-level pressure before takeoff. In the tests the former condition was simulated by pressurizing to 23 psia. For each pressure condition, the container successfully withstood cycling from room temperature to 0°C and then to 60°C. Design and acceptance tests have been specified for the container, and further testing will be in accordance with these specifications.

All scheduled tests on Group 1 prototype Satellite A have now been completed. The wiring of the completely assembled prototype B is now complete, and the electrical tests and thermal parameter measurements are nearly complete. The vibration and acceleration tests on this satellite will begin the first week in July; the thermal and vacuum tests will follow and will extend into the first week of August. The assembly and wiring of the electronic modules for prototype C is nearly completed; final assembly of the satellite is scheduled to start 1 July and electrical tests will begin about 15 July. This prototype is now undergoing thermal parameter measurements.

A total of three 20-inch magnesium shells have now been modified to accommodate a second Lyman-alpha ion chamber, and are being prepared as flight units. Two of these now have completely installed pressure systems, and the third is nearing completion. These units will be coated with silicon monoxide starting about mid-July; the assembly and wiring of the electronic modules will begin in the latter part of July. Final assembly of the first flight unit will start in mid-August, at which time the electrical tests on prototype C will have been completed; thus any changes indicated by the results of these tests can be made in the flight units prior to the final preflight testing, which is scheduled to begin in the second week of September.

Group 2 Satellites

An aluminum prototype of the Group 2 satellite has been assembled at NRL, fully instrumented, and vibration tested in accordance with the adopted environmental test procedures.* No damage to the satellite skin or structure was apparent, although some screws were loosened and dropped out of the Kel-F base. The satellite is believed to be structurally adequate for the forces involved in this test. The pressurized internal instrument container was tested in the same manner as the container for the Group 1 satellites, and appears to present no problems.

*P.V.R. No. 17, Appendix A

Group 3 Satellites

Various materials and fabricators for the Group 3 satellites are still under investigation. Studies have shown that materials containing asbestos will be unsuitable because of the magnetite in the asbestos. A fabricator has been located who, it is believed, could manufacture satisfactory parts for these satellites from a suitable material.

Group 4 Satellites

An aluminum prototype of the satellite for the Signal Engineering Laboratories' proposed cloud cover analysis* has been fabricated at NRL and shipped to SEL for instrumenting and testing. An aluminum prototype of the design for the alternate Group 4 proposal, i.e., the radiation balance experiment, has been completed and will soon be shipped to the University of Wisconsin.

6.44-Inch Satellites

Three aluminum prototypes of the six-antenna 6.44-inch satellite have been fabricated at NRL, and three more will be fabricated in the near future. All six units will incorporate changes which have been made in the design of the antennas and separation mechanism. One of these satellites, with antennas, solar batteries, and a simulated internal package load, has been vibrated in the direction of thrust through level III of the adopted environmental test specifications.† It successfully withstood levels I and II except for a few loosened screws in the shell and loosened nuts on the explosive bolts, which were tightened before the testing continued. After 3 minutes in the level III vibration, the explosive bolt sheared and the satellite fell to the floor, bending one antenna. The antenna was removed, the satellite inspected, the separation sleeve replaced, and a second attempt to run the level III vibration test was made. This attempt was terminated after 2 minutes 35 seconds, when bending of the explosive bolts was noted. This occasioned the aforementioned changes in the explosive bolt separation assembly. Further testing will begin when the changes have been completed.

Effects of Spin-Rocket Exhaust

A test has been performed to determine the effects of the spin-rocket combustion products on the satellite surface. The setup consisted of an expended third-stage bottle housed in an aluminum cylinder and secured to an aluminum plate on which two spin-rockets were mounted. A magnesium 20-inch satellite with the standard silicon monoxide coating was positioned on the third-stage bottle. The entire test was run in a chamber which simulated an altitude of about 150,000 feet. The satellite shell was heated to 200°F and the spin rockets were fired. Subsequent inspection revealed a greasy deposit on the satellite's surface which is likely to be detrimental to its thermal and optical properties as well as to the operation of the Lyman-alpha ion chambers. Studies have been undertaken to overcome this problem.

Satellite Separation Mechanisms

The visual inspection, dimensional checks, and recording of weights have been completed on all of the separation mechanisms for the 20-inch satellites. In addition, the

*P.V.R. No. 17, p. 12

†P.V.R. No. 17, Appendix A

static forces necessary to begin downward movement of the "g-weight"* and to arm the mechanism have been determined. Studies are now underway to determine the factors affecting the reliability of the explosive caterpillar motors and of the batteries. Timing checks, acceleration, separation, and possibly vibration tests will be performed on these mechanisms in the near future.

SCIENTIFIC EXPERIMENTS AND INSTRUMENTATION

Group 1 Experiments

Environmental Experiments

A tentative design for a cadmium sulfide photosensitive type erosion gage has been established, and delivery of the first units may be possible early in July; in that event the new gage will be used in place of the chromium resistance type in the environmental tests on Group 1 prototype Satellite C.

Telemetering and Tracking

The modulated Minitrack transmitter installed in Satellite B was tested over the temperature range from -10°C to +60°C. It showed an average power output of 80 milliwatts from -10°C to 0°C and as the temperature was increased to +60°C the power output slowly decreased to 60 milliwatts. The highest frequency was 108.0001 Mc at +10°C and the lowest frequency 107.9994 Mc at +50°C. The frequency shift of 700 cycles due to temperature is well within the frequency accuracy requirements of the Minitrack system. Vibration tests on this unit will be performed early in July.

A Minitrack transmitter intended for Satellite C failed during a preliminary vibration test in which the transmitter was attached directly to the table and subjected to a white noise test to an rms level of 20 g. The two transistors in this unit had previously passed a similar nonoperating acceptance test. Six other transmitters have passed this preliminary vibration test under identical conditions.

The faulty transmitter has been replaced with a unit that has a power output of 88 milliwatts at -10°C, decreasing to 75 milliwatts at +60°C. The frequency is between 108.0013 and 107.9985 Mc throughout this temperature range.

Group 2 Experiments

An assembled aluminum prototype of the Group 2 satellite was tested to the design test levels on the random vibration equipment on 27 June. Difficulties were encountered in the operation of the command system because of amplitude modulation on the receiver local oscillator signal derived from the transmitter. A balanced mixer is being developed to correct this discrepancy. Difficulties were also encountered because of insufficient isolation between the transmitter output and the receiver input. An isolating network is now under development.

*P.V.R. No. 11, p. 13

Transmitters for 6.44-Inch Satellites

The first ten negative-temperature-coefficient quartz crystals received from the manufacturer were found to have the general characteristics which were specified. Thirty additional units have been received and are presently being evaluated.

Most details of mounting the two transmitters in the sphere have been worked out. A model of each of the transmitters has been designed and constructed, and temperature tests have been made on each. The foam-potted assembly of seven RM-12R mercury cells which supplies the power for one transmitter (the second transmitter is powered by solar cells) has been packaged in a hermetically sealed compartment of the cylindrical container in which the transmitter is mounted.

The electronics of the battery-powered model transmitter have been foam-potted preparatory to vibration tests. The solar-powered transmitter will be potted in foam plastic prior to vibration tests, which will be made with both transmitters mounted in the sphere. Also, in preparation for electrical tests on the transmitters during the vibration tests, solar cells mounted on the surface of the sphere are being wired to supply the solar-powered transmitter. For vibration tests these would necessarily be energized from an artificial source, but for other tests the solar cells would be energized by sunlight.

Satellite Battery Tests

Tests run in April indicated that the effect of vacuum on the life of mercury cells at room temperature is negligible. Tests were run on cell types RM450, RM1, RM12, and RM42 consisting of eight test cells at room temperature in a vacuum and two controls at room temperature in air. Recent tests on seven RM12 cells at a temperature of 60°C indicate that a vacuum will reduce the life of the batteries to 40 percent of the nominal life. Tests are now being conducted to determine the reduction in life caused by operation at +80°C in a vacuum.

The effect of temperature on battery life at atmospheric pressure has been checked at -20°C, -10°C, and +80°C. At the low temperatures the cell voltage decreases rapidly and at -20°C the cell is not a useful power supply. At -10°C the life is 55 percent of the nominal life if the equipment will operate on a terminal voltage reduced to 70 percent of the open-circuit cell voltage. The life of the cell at +80°C is reduced to 75 percent of the nominal life. Additional tests are now in progress which will provide data for a curve of life vs temperature.

Random vibration tests have been run on seven type RM42 cells to a level of 30 g for 4 minutes in each of three planes. This is a higher level than the design test levels. After the vibration the batteries were discharged at room temperature in air at a rate equivalent to their discharge rate in the satellite. Of the seven cells tested, one failed at about 50 percent of the nominal life and the remaining six failed near 85 percent. The results of these tests indicate that vibration decreases the life of the batteries. Tests are planned for vibration levels equal to the design test levels, acceptance test levels, and levels equal to measured rocket vibration, to establish the damage to be expected from each of these sets of conditions.

ELECTRONIC INSTRUMENTATION

TELEMETERING

PWM/FM Systems

The extensively modified (Model 4) pwm/fm telemetering transmitter* has passed all electrical and environmental tests, and has been delivered to The Martin Co. for TV-5. This represents a weight saving of 8 pounds in the second stage where weight is of extreme importance.

Environmental tests have been successfully performed on a Model 2A transmitter, which originally was a dynamotor-powered transmitter and has been modified to use a transistorized power supply. The results of the change are an increase of 5 watts in the output power of the transmitter, and a decrease of about 4 pounds in weight. It may be possible to replace the Model 2 transmitters with this model in both TV-3 and the TV-3 backup vehicle.

The pwm/fm ground station at the Vanguard telemetry pad at AFMTC is being modified to permit two-link operations.

FM/FM Systems

The transistorized power supply for the fm/fm telemetering transmitter has been completed and bench-checked. The rf power output of the modified transmitter* has been increased from the original 12 watts to 18 watts, the heat dissipation has been improved, and the weight reduction resulting from the use of the transistorized power supply is approximately 3 pounds.

All deliveries are now complete on the contract for nine fm/fm transmitters with the Hoover Electronics Co.

A second fm/fm ground station has been requested from the Bureau of Aeronautics for the Vanguard telemetry pad at AFMTC. Support and test equipment for this station are now being procured.

VEHICLE TRACKING

A total of three C-band and two S-band AN/DPN-48 radar beacons have now been received from the Melpar Co.; one of the C-band units, however, is not acceptable. Excessive relay chatter has been noted in the modulators of several of these beacons and appears to be due to interference from the vibrator power supply. Additional vibration filtering improves the situation but further investigation is required.

TV-3 and the TV-3 backup vehicle will carry both C-band and S-band beacons; TV-4 and all subsequent vehicles will carry only C-band beacons.

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* P.V.R. No. 16, p. 10; and No. 17, p. 19

RANGE SAFETY

Two additional revised AN/ARW-59 command receivers have been delivered by the Connecticut Telephone and Electric Co. Two more are scheduled for delivery about 8 July.

The first prototype of the transistorized decoder for use with these command receivers has undergone environmental tests, and several failures occurred. Mechanical design changes intended to overcome the failures due to vibration have been completed and further vibration tests are scheduled. Investigation of the failures due to heat indicates they may be overcome by using silicon rather than germanium transistors.

THE MINITRACK SYSTEM

SYSTEM CALIBRATION

Since 15 May 1957 several tests have been performed with signals reflected from the moon to determine the suitability of such a signal source as a means of calibrating the Minitrack system both in angle and in receiver sensitivity. For the angle measurement the moon is valuable because it covers ± 20 degrees in declination in two weeks time, and a single transmitter can furnish calibration signals for stations over half of the earth's surface.

An advantage of this method over the radio star sources is that the source is a discrete frequency and hence requires no modification in receiving equipment. An advantage over the high-flying airplane is that the source is effectively at infinity. Disadvantages are the low and variable received signal strength, and the uncertainty as to the reflection center of the moon.

The first tracking system modified for this purpose was the Mark II Minitrack System. The signal source used was the 151.11-Mc transmitter operated by Army Signal Corps personnel at Belmar, New Jersey, with a 50-foot parabolic antenna. The Mark II system was modified by changing the frequency of the preamplifier to 151.11 Mc and by using a suitable local oscillator frequency. In addition, the i.f. was changed so that a bandwidth of either 500 or 5000 cps was available. The receiving antennas used were the twelve-dipole arrays built for the Minitrack system by the Technical Appliance Corporation. Because of their narrow north-south beamwidth, these antennas were tilted 30 degrees to the south. They were placed on the old NE and NW antenna rails and were matched to a voltage-standing-wave ratio of less than 2/1 by means of hybrid E-H tuners. Some Heliax cable available at the Blossom Point Minitrack site was used as the transmission line.

After several tests had shown the feasibility of receiving these signals with the Mark II System, a modification kit was built for the Prime Minitrack System. Two preamplifiers were built to amplify 151.11-Mc signal and a suitable local oscillator frequency was used to beat this frequency to 108 Mc. There were no other modifications. The received signals varied greatly from day to day and within particular runs. This variation, reported by many observers, is variously ascribed to ionospheric Faraday rotation, multipath reflection, and libration of the moon's surface. Tests run with pulses have shown that there is no correlation between the signals received at Blossom Point and those received at Asbury Park. To eliminate ionospheric Faraday rotation as the possible cause, the Signal Corps has agreed to build a circularly polarized feed for its 50-foot antenna. This feed is now under construction, and is expected to be available by 1 August.

Since the work at 151.11 Mc appeared promising, discussions were held at the Evans Signal Laboratories to investigate the possibility of having the Signal Corps provide a 108-Mc calibration signal. The Signal Corps personnel were most cooperative and it appears possible to implement the program on the following basis:

1. NRL would furnish ESL with a 108-Mc cw oscillator radiating about 50 kilowatts.

2. NRL would fund the purchase of a suitable feed for the ESL antenna.

3. ESL would furnish a high-voltage power supply (10 kv at 10 A) for the high-powered transmitter.

4. ESL would furnish operating personnel.

The cost of the NRL transmitter will depend on tests of an oscillator-amplifier which was built at NRL for 90-Mc operation but which may work at 108 Mc, in which case the design is complete. The results of these tests are expected by 10 July. If the tests are unfavorable, considerable design work must be done. This transmitter is designed to furnish about 25 kilowatts. To obtain 50 kilowatts, the output of two amplifiers must be combined in a hybrid junction.

Design work on the 108-Mc Minitrack transmitters for use as test signal sources in an aircraft has been completed, and initial production is underway at NRL.

GROUND STATION ESTABLISHMENT

The installation of production Minitrack antennas at the Blossom Point Station is now complete. This and the use of Styroflex transmission lines make this station identical with the other planned Prime Minitrack Stations.

The telemetry receiving antenna has been installed at Blossom Point and is operating, and preparations are underway to check at the proposed mode of operation of this system during aircraft calibration flights. The telemetry command transmitters, receiver, and tape recorder have been installed and preliminary system checks are in progress.

The installation of Minitrack antennas has been completed at the Fort Stewart, Georgia, Station and is in progress at the Antigua and San Diego Stations. The Minitrack trailer shipments to the stations are on schedule, and the last of the trailers will leave NRL about 7 August.

DATA PROCESSING

TELEMETERED DATA

The final report on the reduced ppm/am data from the nose-cone experiment in TV-0 have been received from the New Mexico College of Agriculture and Mechanic Arts.

The ppm/am digital magnetic-tape recording made experimentally during the flight of TV-1 has been successfully played back through the interim data reduction system of the Automatic Recording and Reduction Facility (ARRF) being built by Radiation, Inc. (Orlando, Florida). Teledeltos output records of the uncommutated channels were made satisfactorily at various paper speeds. The output data were not linearized since this feature was not included in the interim system. Because the subcommutator synchronization signal was faulty during the flight, it was not possible to decommutate the subcommutated channels with the automatic data reduction system.

The subchannel selector designed at NRL for incorporation in the ARRF has been delivered to Radiation, Inc. When this equipment is installed, probably early in July, NRL personnel will join the contractor personnel in checking it out.

Both the Digital Data Recording System and the Digital Data Reduction System of the ARRF are expected to be completely assembled in final form by the end of July. Digital magnetic tape records will be made at Cape Canaveral with the recording system for the static and flight firings of TV-2. Automatic data reduction from these records will be performed at the Radiation, Inc. plant at Orlando, Florida.

ORBITAL DATA

The IBM 704 at the Vanguard Computing Center was first put into operation in mid-June. It has been used since then in checking programs and performing test calculations for subroutines which will be employed in orbit determination and prediction. The group of IBM mathematicians continued their programming work, and spent some time with NRL personnel in preparing a suitable demonstration for the opening of the Center, now planned for 2 July 1957.

A private telephone line and a single Teletype line with associated terminal equipment have been installed for communications between the Computing Center at 615 Pennsylvania Avenue and the Vanguard Control Center at NRL. During July two additional Teletype lines and terminal equipment will be installed between the two centers.

THIRD-STAGE FIRING PREDICTION

The AN/FPS-16(XN-1) radar has been checked out and put into tracking operation at RCA (Moorestown, N. J.). Because of delay in preparation of the radar site at PAFB, the radar shipment from Moorestown was shifted first from 14 June to 28 June and then to the second week in July. The contract for the facilities at the XN-1 radar site was handled by the Army Corps of Engineers and was signed by the contractor on 21 June 1957. It is expected that the trailer pad and the concrete platform for the radar antenna will be ready

about the middle of July. On this basis the radar will probably be in first operation by the end of July.

The installation of the AN/FPS-16(XN-2) radar on Grand Bahama Island by RCA personnel is continuing. Good progress has been made despite difficult working and living conditions. First operation of this radar is still expected about mid-July.

Although both the XN-1 and XN-2 radars will probably track TV-2 when it is launched, only the XN-1 is expected to be capable of transmitting data to the IBM 704 computer at Cape Canaveral for digital impact prediction for this firing.

The digital data transmission equipment being built by the Milgo Electronic Corporation (Miami, Florida) for the XN-1 radar is now scheduled for delivery at PAFB by 15 July. The corresponding digital receiving equipment for use with the IBM 704 computer at Cape Canaveral is to be delivered a week later.

The ground-controlled third-stage firing system is still expected to be completed by September 1957 to allow ample time for checking it out prior to use in the launching of TV-3. The G. M. Giannini Corporation has delivered the equipment for quantizing the pwm/fm telemetered output of the coasting time computer, and the operation of the equipment is satisfactory. It will probably be sent to AFMTC in July for shipment to the telemetry building at Grand Bahama Island, where it will be used as part of the ground-controlled third-stage firing system.

RANGE OPERATIONS

TV-2 arrived at AFMTC on 17 June 1957. The receiving inspection is still underway, since various items were to be shipped separately and not all of these have arrived. The second and third stages of this vehicle are inert and will not be separated; they are the correct weight and configuration, however, so that a realistic flight test of the first-stage propulsion and of the overall configuration will be obtained. Inspection of the first stage has revealed some contamination of the propulsion system by foreign matter, but no details are available as yet.

The launching of TV-2 is scheduled for 26 July.

* * *

Project Vanguard
U. S. Naval Research Laboratory
Status of Contract Nonr 1817(00) (The Martin Company) for Vehicle Development
as of 31 May 1957
(in thousands of dollars)

Contract Element	NRL Estimate of Cost to Completion	Martin Estimate of Cost Committed to Date	Actual Costs & Obligations Incurred to Date by Martin Co.		
			Costs	Obligations	Total
Martin Direct Costs & Fee	24,941	19,226	12,346	661	13,007
Subcontracts:					
General Electric (Stage 1)	15,509	12,135	7,781	2,397	10,178
Aerojet (Stage 2)	8,137	7,237	4,805	1,933	6,738
Grand Central (Stage 3)	1,929	1,929	1,080	689	1,769
Other Subs & Spares	6,595	4,668	1,560	1,072	2,632
Total Costs and Fee	57,111	45,195	27,572	6,752	34,324

FISCAL REPORT

Project Vanguard
U. S. Naval Research Laboratory
Monthly Fiscal Status Report as of 30 June 1957
(in thousands of dollars)

Fiscal Item	Sub-Programs				Total Programmed	Contingency Estimate	Total with Contingency
	Vehicles	Radio Tracking	Theory & Data	Science Program			
Approved Budget to Completion	68,242	12,143	3,400	2,641*	86,426*	9,700	96,126
Funds Programmed to Date	-	-	-	-	86,426	9,700	96,126
Funds Allotted to Date	-	-	-	-	61,926†	-	-
Initiations	47,347	8,496	1,951	1,077	59,171	-	-
Obligations‡	46,185	7,869	1,951	1,077	57,082	-	-
Accrued Cost (expenditures)‡	33,110	4,008	685	1,009	38,812	-	-
Obligations Incurred by Fiscal Year:							
1956	31,599	1,499	1,269	192	34,559	-	-
1957	14,586	6,370	682	885	22,523	-	-

*The Science Program includes the additional 746 thousand contained in the current appropriation request to Congress for satellite testing and instrumentation. This increases the NRL budget as shown in NRL Report 4969 of 1 June 1957 from 85,680 to 86,426.

†DOD Emergency Fund: 46,300
Classified Source: 2,500
NSF-NAS IGY Funds: 13,126
Total: 61,926

‡NRL operates on the Navy Industrial Fund; Prior Year obligations are expended as current year "accrued cost" and are therefore not classed by Fiscal Year as in appropriation accounting.

CONFIDENTIAL

Naval Research Laboratory. Report 5010 (CONF.) PROJECT VANGUARD REPORT NO. 19 - PROGRESS THROUGH MAY 31, 1957 (Unclassified Title), by Project Vanguard Staff, 17 pp. & figs., August 6, 1957.

This report is intended as a general summary of the progress on Project Vanguard during the indicated period. Hence, minor phases of the work are not discussed to a great extent, and technical detail is kept at a minimum. It is hoped that the information here presented will be of assistance to administrative and liaison personnel in coordinating and planning their activities, and as a guide to the current status of the project. Material of a more technical nature will be published from time to time in separate reports which will be announced in subsequent monthly progress reports.

CONFIDENTIAL

1. Satellite vehicles - Launching
2. Satellite vehicles - Research
3. Rockets - Development

I. Project Vanguard

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I. Project Vanguard

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4767 - ADO 341439
4728 - ADO 342793
4717 - not in DTIC
4800 - ADC 342755
4815 - ADO 342991
4860 - AD0342505
4880 - ADO 343187
4890 - ADO 343093
4900 - ADO 342883
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